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Science:
Meaning, Emergence and Development of Research in India
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Science India

Introduction

Science (from the Latin scientia, meaning "knowledge") is an enterprise that builds and organizes knowledge in the form of testable explanations of things. [1,2]. In its oldest and broadest sense, science is also that body of reliable knowledge that can be logically and convincingly explained.

Since classical antiquity science as a type of knowledge was closely linked to philosophy, which was the corresponding way of life. And into early modern times the two words were sometimes used interchangeably in the English language. By the 17th century, "natural philosophy" (which is today called "natural science") could be considered separately from "philosophy" in general, but "science" continued to also be used in a broad sense denoting reliable knowledge about a topic, in the same way it is still used in modern terms such as library science, political science, and computer science. The more narrow sense of "science" which is common today, developed as natural philosophy became a distinct enterprise of defining "laws of nature" (for example Kepler’s laws, Galileo’s laws, and Newton’s laws of motion). In this period it became more common to refer to natural philosophy as "natural science". Over the course of the 19th century, the word "science" became increasingly
strongly associated with the disciplined study of the natural world, for example Physics and Chemistry. Many of the other areas of scientific study outside the natural sciences such as are today classified as social sciences and treated as being less scientific, or not "hard science" [3].

**Basic Classifications**

Scientific fields are commonly divided into two major groups: natural sciences, which study natural phenomena (including biological life), and social sciences, which study human behavior and societies. These groupings are an empirical sciences, which means the knowledge must be based on observable phenomena and capable of being tested for its validity by other researchers working under the same conditions. There are also related disciplines that are grouped into interdisciplinary and applied sciences, such as engineering and health science. Within these categories are specialized scientific fields that can include elements of other scientific disciplines but often possess their own terminology and body of expertise. [3].

Mathematics, which is classified as a formal science, has both similarities and differences with the natural and social sciences. It is similar to empirical sciences in that it involves an objective, careful and systematic study of an area of knowledge; it
is different because of its method of verifying its knowledge, using \textit{a priori} rather than empirical methods. Formal science, which also includes statistics and logic, is vital to the empirical sciences. Major advances in formal science have often led to major advances in the empirical sciences. The formal sciences are essential in the formation of hypotheses, theories, and laws, both in discovering and describing how things work (natural sciences) and how people think and act (social sciences).

**History and Etymology**

While disciplined empirical investigations of the natural world have been described since classical antiquity (for example, by Aristotle and Pliny the Elder), and scientific methods have been employed since the Middle Ages (for example, by Alhazen and Roger Bacon), the dawn of modern science is generally traced back to the early modern period during what is known as the Scientific Revolution of the 16th and 17th centuries. This period was marked by a new way of studying the natural world, by methodical experimentation aimed at defining "laws of nature" while avoiding concerns with metaphysical concerns such as Aristotle's theory of causation.

This modern science developed from an older and broader enterprise. The word "science" is from Old French, and in turn from Latin \textit{scientia} which was one of
several words for "knowledge" in that language. In philosophical contexts, scientia and "science" were used to translate the Greek word epistemē, which had acquired a specific definition in Greek philosophy, especially Aristotle, as a type of reliable knowledge which is built up logically from strong premises, and can be communicated and taught.

From the Middle Ages to the Enlightenment, science or scientia continued to be used in this broad sense, which was still common until the twentieth century.[4] Science therefore had the same sort of very broad meaning that philosophy had at that time. In other languages, including French, Spanish, Portuguese, and Italian, the word corresponding to science also carries this meaning.

Prior to the 18th century, the preferred term for the study of nature among English speakers was "natural philosophy", while other philosophical disciplines (e.g., logic, metaphysics, epistemology, ethics and aesthetics) were typically referred to as "moral philosophy". Today, "moral philosophy" is more-or-less synonymous with "ethics". Well into the 18th century, science and natural philosophy were not quite synonymous, but only became so later with the direct use of what would become known formally as the scientific method. By contrast, the word "science" in English was still used in the 17th century to refer to the Aristotelian concept of knowledge which was secure enough to be used as a prescription for exactly how to
accomplish a specific task. With respect to the transitional usage of the term "natural philosophy" in this period, the philosopher John Locke wrote disparagingly in 1690 that "natural philosophy is not capable of being made a science". [5]

Locke's assertion notwithstanding, by the early 19th century natural philosophy had begun to separate from philosophy, though it often retained a very broad meaning. In many cases, science continued to stand for reliable knowledge about any topic, in the same way it is still used today in the broad sense (see the introduction to this article) in modern terms such as library science, political science, and computer science. In the more narrow sense of science, as natural philosophy became linked to an expanding set of well-defined laws (beginning with Galileo's laws, Kepler's laws, and Newton's laws for motion), it became more popular to refer to natural philosophy as natural science. Over the course of the 19th century, moreover, there was an increased tendency to associate science with study of the natural world (that is, the non-human world). This move sometimes left the study of human thought and society (what would come to be called social science) in a linguistic limbo by the end of the century and into the next.

Through the 19th century, many English speakers were increasingly differentiating science (i.e., the natural sciences) from all other forms of knowledge in a variety of ways. The now-familiar expression “scientific method,” which refers
to the \textit{prescriptive} part of how to make discoveries in natural philosophy, was almost unused until then, but became widespread after the 1870s, though there was rarely total agreement about just what it entailed. [6]. The word "scientist," meant to refer to a systematically working natural philosopher, (as opposed to an intuitive or empirically minded one) was coined in 1833 by William Whewell. [7]. Discussion of scientists as a special group of people who did science, even if their attributes were up for debate, grew in the last half of the 19th century. Whatever people actually meant by these terms at first, they ultimately depicted science, in the narrow sense of the habitual use of the scientific method and the knowledge derived from it, as something deeply distinguished from all other realms of human endeavor.

By the 20th century, the modern notion of science as a special kind of knowledge about the world, practiced by a distinct group and pursued through a unique method, was essentially in place. It was used to give legitimacy to a variety of fields through such titles as "scientific" medicine, engineering, advertising, or motherhood. Over the 20th century, links between science and technology also grew increasingly strong. As Martin Rees explains, progresses in scientific understanding and technology have been synergistic and vital to one another.

Richard Feynman described science in the following way for his students:
"The principle of science, the definition, almost, is the following: The test of all
*knowledge is experiment.* Experiment is the *sole judge* of scientific 'truth'. But what is the source of knowledge? Where do the laws that are to be tested come from? Experiment, itself, helps to produce these laws, in the sense that it gives us hints. But also needed is imagination to create from these hints the great generalizations — to guess at the wonderful, simple, but very strange patterns beneath them all, and then to experiment to check again whether we have made the right guess." Feynman also observed, "...there is an expanding frontier of ignorance...things must be learned only to be unlearned again or, more likely, to be corrected.[8].

**Science Education and Research in India**

**Historical Background**

With a long and chequered history of education and training in pure and applied sciences dating back to over 2,600 years, India has had flourishing tradition of scientific research and technological development. Taxila, (6th century BC) was one of the earliest universities in the world, attracted students from across the continents. Major fields of study at Taxila included mathematics, astronomy, medicine, surgery and metallurgy. Unfortunately, most of the knowledge was lost
during the medieval period. The glorious tradition of original thinking, adventure of ideas and creative innovations was completely snapped.

**Science and Science Education during the British Rule**

The development of modern science in India is not an organic extension of the earlier tradition. It is an implant by the British in a language that was alien to its people. As with other implants, it needed nourishment and nurturing to be absorbed in the society. Science education was lacking and science was looked upon as an appendage thrust by the British for their own benefit.

Until a few decades towards the end of the British rule, the role of science education, scientific and technological research in economic growth and social transformation was rather limited. Only such developments were introduced that did not lead to a conflict with the interests of the colonial power. The only aim of education including that of science education was to turn out men competent to serve the civilian administration. Consequently, science education and research was uneven and patchy with no facilities. Even those few individuals educated in science lacked opportunities for either gainful employment or for scientific research. They could only procure clerical or teaching jobs.

It was only in 1857 that the universities of Bombay, Calcutta and Madras, modelled after the London University, were established. As a concession to the
Indian aspirations the foundations for basic sciences were expanded and academic science in the universities received a fillip.

It must be stressed that even under such adverse conditions, globally competitive scientific research was carried out by a few scientists like, C.V. Raman, M.N. Saha, S.N. Bose, D.N. Wadia, P.C. Mahalanobis, S. R. Kashyap, Birbal Sahni, S.Ramanujan, S. Chandrashekhar. Many of these were trained in India and carried out their research in Indian universities. The outbreak of the World War I brought about a radical change in science education and in the pattern of scientific research and technological developments. The colonial government being cutoff from Britain was forced to actively mobilize local resources of scientific and technical personnel to meet wartime needs.[9]

Post – Independence Period: Nehru’s Vision

Within a few decades of the end of World War I, major colonial empires had disintegrated and India became independent in 1947. It is indeed very fortunate that Jawaharlal Nehru was India’s first Prime Minister. Having witnessed first hand the remarkable developments brought out through the pursuit of science in Europe and particularly in the then Soviet Union, he more than anyone else, realized the crucial importance of science for economic growth and social transformation. Addressing the then National Institute of Sciences (now INSA), Nehru stated, who indeed can
afford to ignore science today? At every turn, we have to seek its aid and the whole fabric of the world is of its making. He strongly emphasized the inherent obligation of a great country like India with its tradition of original thinking to participate fully in the march of science. It was equally fortunate that in laying the firm foundation of science and science education in the country, Nehru’s vision was shared by the then leaders in science who helped Nehru to realize his vision.

Raman, one of India’s most eminent scientists said, there is only one solution for India’s economic problems and that is science, more science and still more science. Homi Bhabha, the father of India’s atomic energy programme, while addressing the General Assembly of the International Council of Scientific Unions, just before his death, emphasized, What developed countries have and what developing countries lack is modern science and an economy based on modern technology. The problem of developing countries is therefore the problem of establishing modern science and transforming their stagnant and traditional economy to the one based on modern science and technology. Bhabha went on to add, An important question we must consider is whether it is possible to transform the traditional economy to the one based on modern technology developed elsewhere without at the same time establishing modern science in the country as a live and vital force? If the answer to this question is in the negative and I believe our experience shows it to be so, then the problem of establishing science as a live and vital force is an
inseparable part of transforming an industrially underdeveloped country to a developed country. In the context of establishing modern science and technology as a live and vital force, the importance of science education cannot be over-emphasized. Indeed, science education plays a crucial and pivotal role in the alchemy of scientific research and technological innovations.[9].

Policy Frame

The vision of Nehru of India becoming a beacon spreading to the world not only the message of Buddha and Gandhi of peace and universal brotherhood but also that of science and technology, was translated into working plans through a policy frame that has evolved over the years. The very constitution of the Republic of India (seventh schedule) squarely puts the responsibility for coordination and the determination of standards in the institutions of higher learning and research on the central government, its responsibility also includes central universities, Indian Institute of Science, Institutes of Technology and institutes of national importance declared by the parliament. The constitutional amendment of 1976 places education including science and technology education in the concurrent list which implies the joint responsibility of the central and the state governments. The Government of India has evolved a machinery to discharge these obligations by designating Ministry of Human Resource Development to function as an administrative ministry
and by establishing the University Grants Commission and the All India Council for Technical Education, by acts of parliament to superintend the functioning of higher education in science and technology respectively. While delivering the convocation address of Allahabad University in 1946, Nehru said, *It is science alone that can solve the problems of hunger and poverty, of insanitation and malnutrition, of illiteracy and obscurantism of superstition and deadening customs, of rigid traditions and blind beliefs, of vast resources going to waste of a rich country inhabited by starving millions.*[9].

**Pursuit and Promotion of Science**

Over the years, the Indian parliament has adopted major policy statements relating to higher education and S&T development. These developments have been largely guided by the Scientific Policy Resolution of 1958, one of the most comprehensive science policy documents ever approved by any legislative body in the world. The parliament approved in 1968, the Technology Policy Resolution, which states that research and development together with S&T education and training of a high order will be provided a pride of place. Basic research and building of the centres of excellence will be encouraged. The quality and efficiency of S&T generation and the related delivery system will be continuously monitored and upgraded. The policy statement calls for strengthening linkages between educational institutions, R&D establishments, and industry and government machinery. The central government
has periodically constituted National Commissions on Education to assess the system of education and for recommending ways and means to diversify, improve and update the system, consistent with the changing environment. Some of the commission’s reports were translated into National Policies on Education. Thus the National Commission on Education of 1964 chaired by D.S. Kothari resulted in the preparation of the National Policy of Education in 1968. In 1986, the national Policy was suitably modified, amended and updated. This was further modified in 1992 in the light of Ramamurthy Committees report covering a whole range of operational, financial and technical issues. The statements emphasize education to be a unique investment for the present and the future, with emphasis on equal access on requisite merit, mobility of students and faculty and networking of educational institutions, R&D establishments, greater autonomy and accountability, relevance of curricula, excellence in research, and mobilization of resources. Thus the statement first made by the Kothari Commission that *the destiny of this country is shaped in the classrooms and laboratories of schools, colleges and universities* is re-echoed. India has committed whole heartedly to science and has provided the necessary policy support for S&T human power development. There is also a systematic planning process in place. The policies and plans have helped India develop a vast infrastructure for higher S&T education, and have provided the second largest manpower in the world, with the best in the system comparable to the best
anywhere in the world. However, inadequate understanding of the spirit of the recommendations has led to over centralization of authority, bureaucratization by controlling agencies and over-dependence on government support and intervention. The system has become too large and monolithic to ensure quality and accountability. [9].

**The University of North Bengal**

The University of North Bengal was established by Act of the Legislature of West Bengal in 1962 and assigned the mandate of providing teaching, training and research in various branches of advanced learning, and promoting the dissemination of knowledge to fulfil growing socio-economic and technical manpower needs in the six North Bengal districts and the neighbouring state of Sikkim. The campus occupies an area of about 330 acres, 9 km outside Siliguri and Bagdogra Airport in the Terai region of Darjeeling district. The University Act was revised under West Bengal Act of XXV of 1981 and it came into force with effect from September 16, 1981.
Topographic Features

Occupying the latitudinal and longitudinal ranges of \(24^\circ40'20''[\text{Malda}]\) and \(87^\circ45'50''E\) [Malda] to \(89^\circ54'35''E\) [Koch Bihar], respectively, the region includes 6 distinct climate regions ranging from tropical to rival within its span from the Barind plain of Bengal to the High Himalaya. It consequently witnesses an altitudinal range of 21 msl. along the Ganga watered in Malda district up to 8467 msl. at the Kanchendzonga peak in Sikkim. Normal annual precipitation in the region varies from just 1453mm in Malda district to 3508 in Cooch Bihar district, crossing 5600mm p.a. in the Eastern hill tracts that neighbour Bhutan. With its proximity to the southernmost sweep of the Himalaya and to the Bay of Bengal, the North Bengal region plays a critical role in the formation and circulation of the South West monsoon system. Heavy precipitation and runoff near the Himalayan ranges has led to the undulating topography of the region and to the formation of vast floodplains around the rivers of the Ganga-Brahmaputra interfluve which drain the region. Of these, the principal rivers flow within the Tista basin.

Objectives

The University has played a pioneering role since inception in spreading higher education and inculcating scientific attitudes within the predominantly rural
areas that comprise its vast jurisdictional territory. Well over 36,000 undergraduate students and over 1500 postgraduate students and scholars now enrol at different courses under the University during any given year. Besides the territory under its immediate jurisdiction, the University also gets students and scholars from adjoining areas in Bihar and the North Eastern states, as also from SAARC countries like Bhutan, Bangladesh and Nepal. Several pioneering contributions made by researchers at the university have contributed to wider understanding of the special problems that confront the Eastern Himalayan and sub-Himalayan region and have provided practical inputs for current developmental interventions in the region.

**Departments and Centres of Higher Learning**

The creation of the department of higher learning which import post graduate, M.Phil, Ph.D and Post Ph.D level training and research, is aimed to have better control and a more successful approach. The university to meet the global requirements of multi disciplinary approaches to teaching and research has adopted this pattern. It is hoped that this will help in forgoing alliance with foreign universities and schools of higher learning and shall benefit students and faculty of North Bengal University both academically as well in the new career opportunities.
To promote interdisciplinary interactive teaching, research and international collaboration, the Executive Council of North Bengal University, has established the following Faculties, Departments and Centres in its campus as under:

**Faculties of Science:**

- Department of Physics
- Department of Chemistry
- Department of Mathematics
- Department of Geography and Applied Geography
- Department of Botany
- Department of Zoology
- Department of Biotechnology
- Department of Anthropology
- Department of Computer Science and Application
- Department of Microbiology

**Faculty of Arts, Commerce and Law**

- Department of English
- Department of Bengali
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- Department of Political Science
- Department of History
- Department of Philosophy
- Department of Commerce
- Department of Sociology
- Department of Nepali
- Department of Law
- Department of Hindi
- Department of Library and Information Science
- Department of Strategic and Area Studies
- Department of Adult, Continuing Education, Extension and Field Outreach

Centres: Faculty of Science

- Centre for High Energy and Cosmic Ray Physics
- Computer Centre
- Centre for Remote Sensing Applications
- U.S.I.C
- Information Technology Centre
- Institute of Plantation Science and Management
- Centre for Floriculture and Agro-business Management
Faculty of Arts, Commerce and Law

- Centre for Himalayan Studies
- Centre for Women’s Studies
- Centre for Developmental Studies
- Centre for Studies in Local Languages and Culture
- Directorate for Distance Education
- Prof. Nurul Hasan Centre for Management Studies
- Centre for Ambedkar Studies
- Centre for Buddhist Studies

Affiliated Colleges under North Bengal University:

- A C Training College, Jalpaiguri
- A.B.N. Seal College, Coochbehar
- Alipurduar College, Alipurduar
- Ananda Chandra College of Commerce, Jalpaiguri
- Ananda Chandra College, Jalpaiguri
- Baxirhat Mahavidyalay, Baxirhat, Coochbehar
- Bijanbari College
- Birpara College, Birpara
- Cluny Women’s College, Kalimpong
Cooch Beher College, Coochbehar
Darjeeling Govt. College, Darjeeling
Dinhata College, Dinhata
Eastern Dooars B. Ed College, Alipurduar
Falakata College, Falakata
Ghoom- Jorbunglow Degee College, Darjeeling
Gyan Jyoti College, Siliguri
Islam Pur College, Islampur
Jalpaiguri Law College, Jalpaiguri
Kalimpong College, Kalimpong
Kurseong College, Kurseong
Loreto College, Darjeeling
Mathabhanga College, Mathabhanga
Mekhliganj College, Mekhliganj
Mirik College, Mirik
Nani Bhattacharya Smarak Mahavidyalaya
Netaji Subhas Mahavidyalay, Haldibari
P.D Women’s College, Jalpaiguri
Parimal Mitra Smriti Mahavidyalaya
Post Graduate College of Physical Education for Women, Dinhata
Raiganj College (University College), Raiganj
Sahid Kshudiram Mahavidyalaya, Jalpaiguri
Salesian College, Sonada
Siliguri B. Ed College, Kadamtala
Siliguri College of Commerce, Siliguri
Siliguri College, Siliguri
Siliguri Mahila Mahavidyalaya, Siliguri
Sitalkuchi College, Sitalkuchi
Sree R K B T College, Darjeeling
St. Joseph’s College, Darjeeling
Sukanta Mahavidyalay, Dhupguri
Surya Sen Mahavidyalaya, Siliguri
Thakur Panchanan Mahila Mahavidyalaya, Coochbehar
Tufanganj Mahavidyalay, Tufanganj
University B.T. Evening College, Coochbehar
Vivkananda College, Alipurduar
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